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Appeal Brief
(3)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

Kar W. Yung et al.

Serial No.: 08/949,988

Filed: October 14, 1997

For: METHOD AND SYSTEM FOR MAXIMIZING SATELLITE CONSTELLATION COVERAGE

Attorney Docket No.: PD-96315

Group Art Unit: 3641

Examiner: T. DINH

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APPEAL BRIEF UNDER 37 C.F.R. § 1.192

Box AF
Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

This is a brief in support of an appeal from the final rejection of claims 1-19 in the final Office Action mailed on July 8, 1999.

I. Real Party In Interest

The real party in interest is Hughes Electronics Corporation, a corporation organized and existing under the laws of the State of Delaware, and having a place of business at El Segundo, California.

II. Related Appeals and Interferences

There are no other appeals or interferences known to the Applicants, the

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Applicants' legal representative, or the Assignee which will directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

III. Status of Claims

Claims 1-19 are pending in this application (reproduced for reference in the attached Appendix) and are finally rejected and on appeal.

IV. Status of Amendments

An amendment to independent claims 1 and 10 was filed subsequent to the final rejection in the Amendment Under 37 C.F.R. § 1.116 mailed August 1999. The Examiner indicated in the Advisory Action mailed September 1999 that the proposed amendment would be entered upon the filing of a Notice of Appeal and an Appeal Brief.

V. Summary of Invention

Independent claims 1 and 10 provide a method and system for maximizing satellite constellation coverage at predetermined local times for a set of predetermined geographic locations. A satellite constellation having a first coverage is determined. (See page 5, lines 3-16 of the specification.) The satellite constellation includes at least two desired satellites 14. Each of the desired satellites 14 have a trajectory associated therewith. Each of the desired satellites 14 follow a specific trajectory defining the orbit 15 of each satellite as a function of time. (See page 5, lines 17-22 of the specification and FIG. 2.) A period of orbit for each of the desired satellites 14 is then determined. (See page 5, line 23 through page 7, line 12 of the specification.) A time dependent coverage of the satellite constellation based on the orbit period and the trajectory of each of the desired satellites is then determined. (See page 7, lines 13-31 of the specification.)

Because the desired satellite constellation coverage depends on the local time for the set of predetermined geographic locations, it is desirable to have the maximum possible

number of satellites providing coverage at the set of predetermined geographic locations for about 8-12 hours a day during the middle of the day. This is achieved by tilting the trajectory of at least one of the desired satellites 14 to reorient the satellite constellation to obtain a second coverage based on the time dependent coverage. The second coverage providing maximum coverage at the predetermined local times for the set of predetermined geographic locations. (See page 8, lines 1-23 of the specification.) Command signals for modifying the trajectory of the at least one desired satellite based on the tilted trajectory are then generated. (See page 8, line 24 through page 9, line 22 of the specification.)

VI. Issues

1. Whether the proposed revised FIG. 3 filed on April 22, 1999, introduced new matter into the drawings and whether the original disclosure does not support the showing of boxes 24, 26, 28, and 30 of the proposed revised FIG. 3;

2. Whether the Amendment filed on April 22, 1999, of amending independent claims 1 and 10 by adding the limitation of generating command signals based on the tilted trajectory introduced new matter into the disclosure; and

3. Whether U.S. Patent No. 4,809,935 issued to Draim ("Draim") in view of U.S. Patent No. 4,776,540 issued to Westerlund ("Westerlund") or U.S. Patent No. 5,738,309 issued to Fowell ("Fowell") makes a *prima facie* showing of obviousness of claims 1-19.

VII. Grouping of Claims

Claims 1-19 stand or fall together.

VIII. Argument

I. *The original disclosure supports the showing of boxes 24, 26, 28, and 30 of the proposed revised FIG. 3.*

Boxes 20, 22, 24, 26, 28, and 30 of proposed revised FIG. 3 filed on April 22, 1999, are generally supported on page 2, lines 6-28; and page 5, line 1, through page 9, line 22 in the specification. A copy of proposed revised FIG. 3 is reproduced for reference in the attached Appendix.

Box 20 of proposed revised FIG. 3 "Determine Desired Satellite Constellation" is supported by page 5, lines 3-4 of the specification, "a desired satellite constellation is determined, as shown at block 20"; page 2, lines 11-12 of the specification, "determining a satellite constellation having a first coverage"; and claim 1, line 4, "determining a satellite constellation having a first coverage."

Box 22 of proposed revised FIG. 3 "Determine Period of Rotation of Each of the Desired Satellites" is supported by page 5, line 23-24 of the specification, "the period of rotation of each of the satellites is determined, as shown at block 22"; page 2, lines 15-16 of the specification, "determining a period of rotation for each of the desired satellites"; and claim 1, line 7, "determining a period of orbit for each of the desired satellites."

Box 24 of proposed revised FIG. 3 "Determine Time Dependent Coverage of Each of the Desired Satellites Based on the Period" is supported by page 7, lines 13-15 of the specification, "Knowing the period of the satellite constellation, the time dependent coverage provided by the satellites can then be determined, as shown at block 24"; page 2, lines 17-19 of the specification, "determining a time dependent coverage of the satellite constellation based on the period of rotation and the trajectory of each of the desired satellites"; and claim 1, lines 8-9, "determining a time dependent coverage of the satellite constellation based on the orbit period and the trajectory of each of the desired satellites."

Box 26 of proposed revised FIG. 3 "Tilt the Trajectory of at Least One of the Desired Satellites to Modify the Coverage Provided by the Constellation" is supported by page 8, lines 6-8 of the specification, "This is achieved by tilting, or reorienting, the satellite constellation around the y axis in the equatorial plane, as shown at block 26"; page 2, lines 20-23 of the specification, "tilting the trajectory of at least one of the desired satellites to

obtain a second coverage based on the time dependent coverage"; and claim 1, lines 10-11, "tilting the trajectory of at least one of the desired satellites to reorient the satellite constellation to obtain a second coverage based on the time dependent coverage."

Box 28 of proposed revised FIG. 3 "Launch the Desired Satellites with the Modified Trajectory" is supported by page 9, lines 10-12 of the specification, "The satellites are then launched into space via the launch vehicle with the new orbital parameters programmed therein, as shown at block 28," generally by page 8, line 29 through page 9, line 9 of the specification, and claim 3, lines 2-3, "launching the at least one desired satellite with orbital parameters programmed therein."

Box 30 of proposed revised FIG. 3 "Generate Command Signals to Modify the Trajectory of the Desired Satellites" is supported by page 9, lines 13-16 of the specification, "For existing satellite constellations, command signals must be generated by the satellite ground station 12 in order to achieve the desired amount of tilting, as shown at block 30"; page 2, lines 26-28 of the specification, "generating command signals for modifying the trajectory of the at least one desired satellite"; page 8, lines 24-26 of the specification, "command signals are generated for modifying the trajectory based on the desired amount of tilting"; and claim 1, lines 14-15, "generating command signals for modifying the trajectory of the at least one desired satellite."

As shown, boxes 24, 26, 28, and 30 of proposed revised FIG. 3 are supported in the specification and in the claims. Accordingly, the Applicants request the Board to direct the replacement of the originally filed FIG. 3 with the proposed revised FIG. 3.

I. *The amendment to claims 1 and 10 of adding the limitation of generating command signals <u>based on the tilted trajectory</u> did not introduce new matter into the disclosure.*

In the Amendment filed April 1999 the Applicants amended a portion of claim 1, lines 14-15 as follows (claim 10 was amended similarly):

generating command signals for modifying the trajectory of the at least one desired satellite based on the tilted trajectory.

Support for the limitation of generating command signals based on the tilted trajectory is found on page 8, lines 24-26 in the specification, "Finally, command signals are generated for modifying the trajectory based on the desired amount of tilting" i.e., based on the tilted trajectory; page 9, lines 13-16 of the specification, "For existing satellite constellations, command signals must be generated by the satellite ground station 12 in order to achieve the desired amount of tilting, as shown at block 30"; and claim 2, lines 2-4, "generating command signals includes programming a computer with orbital parameters **based on the tilted trajectory.**"

Accordingly, the Applicants request the Board to rule that the amendment to claims 1 and 10 of adding the limitation of generating command signals based on the tilted trajectory does not introduce new matter into the disclosure.

II. *U.S. Patent No. 4,809,935 issued to Draim ("Draim") in view of U.S. Patent No. 4,776,540 issued to Westerlund ("Westerlund") or U.S. Patent No. 5,738,309 issued to Fowell ("Fowell") do not make a prima facie showing of obviousness of claims 1-19.*

To establish *prima facie* obviousness of a claimed invention, all of the claim limitations must be taught or suggested by the prior art. *In re Royka*, 490 F.2d 981, 180 USPQ 580 (CCPA 1974). "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970). If an independent claim in non-obvious under 35 U.S.C. § 103, then any claim depending therefrom is non-obvious. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988).

The claimed invention, as recited in independent claims 1 and 10, provides a method and system for maximizing satellite constellation coverage at predetermined local times

for a set of predetermined geographic locations. The satellite constellation coverage includes a first coverage and at least two desired satellites. Each of the desired satellites has a trajectory associated therewith. A period of orbit for each of the desired satellites is determined. A time dependent coverage of the satellite constellation is then determined based on the orbit period and the trajectory of each of the desired satellites.

As described on page 8, lines 1-11 of the specification, maximizing satellite constellation coverage depends on the local time at a predetermined geographical location. It is desirable to have the maximum number of satellites providing coverage at the predetermined geographical location during the middle of the day. This is achieved by tilting, or reorienting, the satellite constellation around the y axis in the equatorial plane. This process is accomplished by rotating the parameters defining the trajectory.

The claimed invention includes tilting the <u>trajectory</u> of at least one of the desired satellites to <u>reorient</u> the <u>satellite constellation</u> to obtain a second coverage <u>based</u> on the time dependent coverage. The second coverage provides maximum coverage at the predetermined local times for the set of predetermined geographical locations. Command signals for modifying the trajectory of the at least one the desired satellites are then generated based on the tilted trajectory.

In the final Office Action, the Examiner cited Draim as disclosing a satellite constellation covering a specific geographical area but being silent on tilting the trajectory to reorient the constellation to cover a second coverage. The Examiner cited Westerlund and Fowell as disclosing tilting satellites to "reorient" the satellite constellation to cover various geographical areas. The Examiner then posited that it would have been obvious to have tilted the trajectory of the satellite constellation of Draim as taught by either Westerlund or Fowell to maximize the coverage area of the desired geographical area.

Draim teaches a satellite constellation for continuous global coverage. Westerlund and Fowell teach tilting satellites per se, *i.e.*, tilting the inclination angle of the satellites. The claimed invention is not tilting a physical object, but rather is <u>tilting the</u>

<u>trajectory of the satellites to reorient the satellite constellation</u> as a function of the time dependent coverage of the satellite constellation prior to tilting. Tilting the trajectory of the satellites may or may not affect the inclination angle of the satellites.

The method and system of the claimed invention provide a general systematic approach to synchronize coverage of an entire satellite constellation consisting of more than one satellite with local time. (See page 1, lines 22-25 of the specification). The tilting process of the method and system of the claimed invention shifts satellite resources towards "hot spots" at certain times. Then the motion of the earth relative to the orbit plane, not necessarily the motion of the earth relative to the individual satellites, brings the satellite resources to the daily traffic at proper times. Thus, the daily coverage provided by the entire satellite constellation matches the traffic needs at predetermined local times. The overall performance of the satellite constellation is thus improved without any alteration to the space segment hardware. (See page 9, line 23 through page 10, line 2 of the specification.)

Thus, even if the prior art cited references were combined, the claimed invention does not follow. None of the references, either alone or in combination, teach or suggest the method and system claimed in claims 1 and 10. Claims 2-9 and 11-19 depend from claims 1 and 10.In view of the foregoing remarks, it is believed that claims 1-19 overcome the rejection under 35 U.S.C. § 103(a).

IX. Summary

It is respectfully submitted that (1) the original disclosure supports the showing of boxes 24, 26, 28, and 30 of the proposed revised FIG. 3, (2) the amendment to claims 1 and 10 of adding the limitation of generating command signals based on the tilted trajectory did not introduce new matter into the disclosure, and (3) claims 1-19 are patentable over any combination of the prior art cited references for the reasons discussed above.

Respectfully submitted,

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APPENDIX

1. A method for maximizing satellite constellation coverage at predetermined local times for a set of predetermined geographic locations, the method comprising:

determining a satellite constellation having a first coverage, the constellation including at least two desired satellites, wherein each of the desired satellites have a trajectory associated therewith;

determining a period of orbit for each of the desired satellites;

determining a time dependent coverage of the satellite constellation based on the orbit period and the trajectory of each of the desired satellites;

tilting the trajectory of at least one of the desired satellites to reorient the satellite constellation to obtain a second coverage based on the time dependent coverage, the second coverage providing maximum coverage at the predetermined local times for the set of predetermined geographic locations; and

generating command signals for modifying the trajectory of the at least one desired satellite based on the tilted trajectory.

2. The method as recited in claim 1 wherein generating the command signals includes programming a computer with orbital parameters based on the tilted trajectory.

3. The method as recited in claim 2 further comprising launching the at least one desired satellite with the orbital parameters programmed therein.

4. The method as recited in claim 1 wherein generating the command signals includes transmitting the command signals to the at least one desired satellite.

5. The method as recited in claim 1 wherein determining the orbit period includes determining if the trajectory of the at least one desired satellite is equatorial.

6. The method as recited in claim 5 wherein determining the orbit period includes determining the orbit period according to the following if the trajectory is equatorial:

$$P = [\, m_s D_s D_N \,/\, (n D_N + m_s D_s) \,],$$

where,

P is the orbit period with its sign indicating whether it is a direct or retrograde orbit;

n is an integer with its absolute value equal to the number of times that the satellite transverses the same geographic longitude within the repeating period;

m_s is the number of mean solar day per repeating period and must be a positive integer relatively prime to n;

D_s is the mean solar day, which is 24 hours or 1440 minutes; and

D_N is the nodal day which is the period of the earth-rotation relative to the ascending node or any point of the orbit plane.

7. The method as recited in claim 5 wherein determining the orbit period includes determining the orbit period according to the following if the trajectory is not equatorial:

where,

$$P = \frac{T}{n+m_N}$$

m_N is the number of nodal day per repeating period which must be a positive integer relatively prime to n; and

T is the repeating period that the coverage pattern starts to repeat itself.

8. The method as recited in claim 1 wherein determining the time dependent coverage includes performing a simulation.

9. The method as recited in claim 1 wherein the trajectory is defined by a first coordinate system and wherein tilting the trajectory comprises:

translating the first coordinate system into rotation matrices;

transforming the rotation matrices based on the tilting; and

determining a second coordinate system based on the transformed rotation matrices.

10. A system for maximizing satellite constellation coverage at predetermined local times for a set of predetermined geographic locations, the satellite

constellation having a first coverage and including at least two desired satellites wherein each of the desired satellites have a trajectory associated therewith, the system comprising:

a processor operative to determine a period of orbit for each of the desired satellites, determine a time dependent coverage of the satellite constellation based on the orbit period and the trajectory of each of the desired satellites, and to tilt the trajectory of at least one of the desired satellites to reorient the satellite constellation to obtain a second coverage based on the time dependent coverage, the second coverage providing maximum coverage at the predetermined local times for the set of predetermined geographic locations; and

means for generating command signals for modifying the trajectory of the at least one desired satellite based on the tilted trajectory.

11. The system as recited in claim 10 wherein the means for generating is a computer programmed to launch the at least one desired satellite into space with the modified trajectory.

12. The system as recited in claim 11 wherein the trajectory is a theoretical trajectory.

13. The system as recited in claim 10 wherein the means for generating is a satellite ground station operative to transmit and receive signals to and from the at least one desired satellite.

14. The system as recited in claim 13 wherein the trajectory is an actual trajectory.

15. The system as recited in claim 10 wherein the processor, in determining the orbit period, is further provided for determining if the trajectory of the at least one desired satellite is equatorial.

16. The system as recited in claim 15 wherein the processor, in determining the orbit period, is further operative to determine the orbit period according to the following if the trajectory is equatorial:

$$P = [\, m_s D_s D_N / (nD_N + m_s D_s) \,],$$

where,

P is the orbit period with its sign indicating whether it is a direct or retrograde orbit;

n is an integer with its absolute value equal to the number of times that the satellite transverses the same geographic longitude within the repeating period;

m_s is the number of mean solar day per repeating period and must be a positive integer relatively prime to n;

D_s is the mean solar day, which is 24 hours or 1440 minutes; and

D_N is the nodal day which is the period of the earth-rotation relative to the ascending node or any point of the orbit plane.

17. The system as recited in claim 15 wherein the processor, in determining the orbit period, is further operative to determine the orbit period according to the following if the trajectory is not equatorial:

where,

$$P = \frac{T}{n+m_N}$$

m_N is the number of nodal day per repeating period which must be a positive integer relatively prime to n; and

T is the repeating period that the coverage pattern starts to repeat itself.

18. The system as recited in claim 10 wherein the processor, in determining the time dependent coverage, is further operative to perform a simulation.

19. The system as recited in claim 10 wherein the trajectory is defined by a first coordinate system and wherein the processor, in tilting the trajectory, is further operative to translate the first coordinate system into rotation matrices, transform the rotation matrices based on the tilting, and determine a second coordinate system based on the transformed rotation matrices.

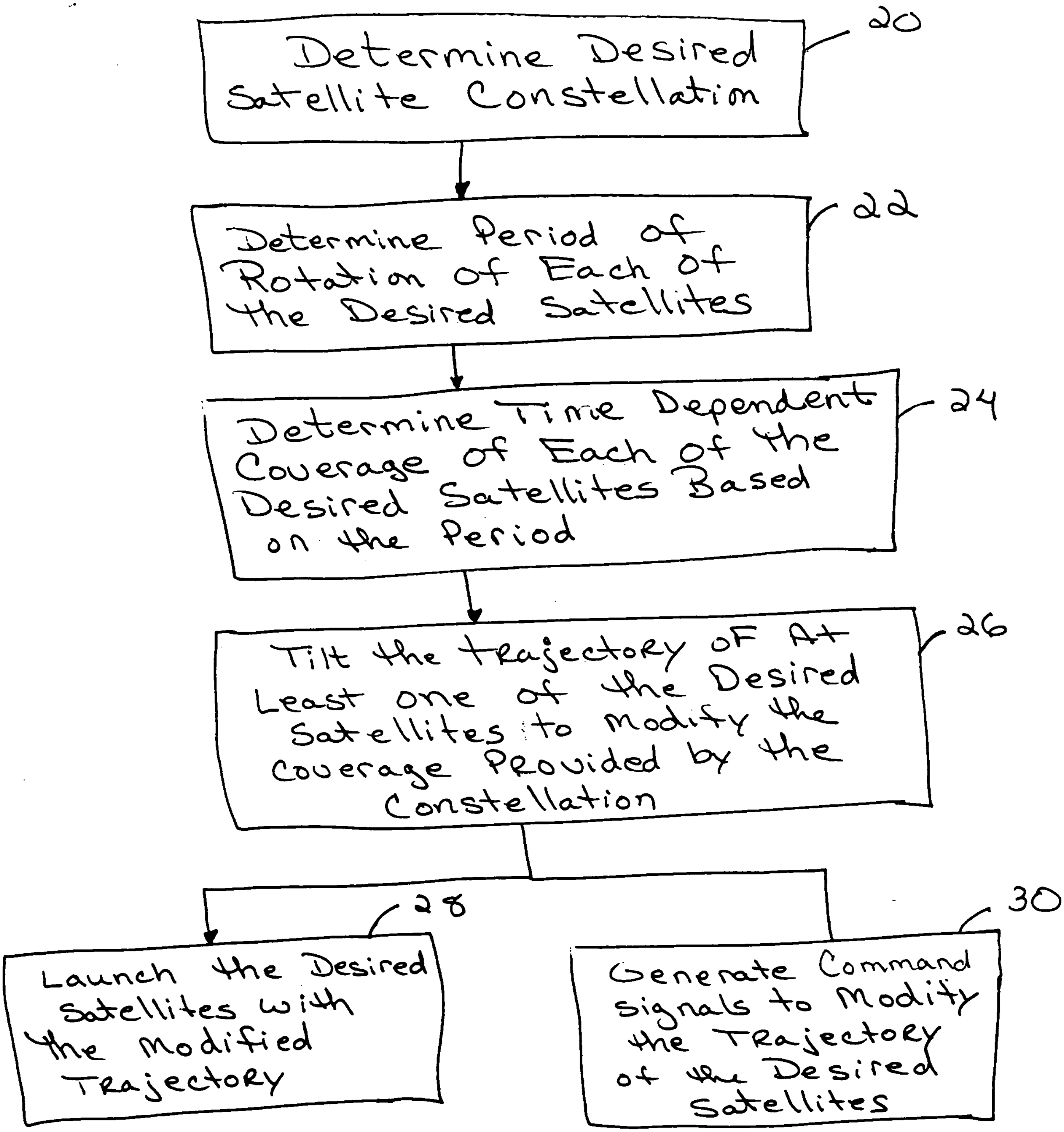

FIG. 3

(PROPOSED REVISED)

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